SCIENCE

NEW SERIES
VOL. LXIX, No. 1789

FRIDAY, APRIL 12, 1929

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

SCIENCE

VOL. LXIX APRIL 12, 1929 No. 1789

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE WORK OF THOMAS BURR OSBORNE (1859–1929)

IT is given to few men to begin a scientific career with an investigation in an obscure and unattractive field, to continue their labors in it throughout a long and active life and ultimately to see this field become one of the most fertile and widely cultivated in their particular domain of science. The work of Thomas Burr Osborne on the vegetable proteins, continued from 1889 until his retirement in 1928, furnishes a striking example of a life devoted almost exclusively to scientific research upon a single group of substances and their derivatives. Owing to the diversified relationships of these substances this work has had a profound influence upon many phases of biochemistry.

Dr. Osborne was born in New Haven, Connecticut, on August 5, 1859. He was graduated from Yale University with the degree of B.A. in 1881, and received his doctorate from Yale in 1885. His dissertation was on "The Quantitative Determination of Niobium." From 1883 to 1886 he was an assistant in analytical chemistry at Yale and during this period published several papers dealing with analytical problems.

In May, 1886, at the invitation of Professor Samuel W. Johnson, professor of agricultural chemistry at Yale and director of the Connecticut Agricultural Experiment Station, Dr. Osborne became a member of the station scientific staff, forming a connection he retained until his death on January 29, 1929. Professor Johnson had become interested in Ritthausen's extensive studies of vegetable proteins. He was fully alive to their significance and suggested that further investigation was desirable. Accordingly, Dr. Osborne began in 1888 the labors that continued without interruption until his retirement.

Dr. Osborne's work on the vegetable proteins falls chronologically into three phases. From 1890 to 1901 the chief interest was in the preparation of pure specimens of the proteins of plant seeds. The initial investigation of the oat kernel, published in 1891, was followed by a series of papers in which the proteins from no less than thirty-two different seeds were described. Each of these was prepared, where possible, by a number of different methods; the criterion for purity and individuality was ultimate analysis for carbon, hydrogen, nitrogen and sulphur.

The properties of these substances were such as clearly to show the advantages for scientific investigation of the reserve proteins of seeds over the proteins of animal origin. Efforts to isolate proteins of definite properties from the complex mixtures in animal tissues had been for the most part unsuccessful, and even as late as 1911 ovalbumin was the only animal protein that had been clearly characterized as a chemical individual. On the other hand, many seed proteins were early shown by Dr. Osborne to be chemical individuals and preparations possessing identical properties were reproducible at any time.

A careful investigation was made of the proteins which had been previously grouped under the terms legumin, conglutin and vitellin, and it was shown that many of the proteins which thus had been brought together were, in fact, distinct substances. Specific designations were, therefore, in many cases coined and the use of the older names was restricted to those proteins to which they had first been applied. This clarification of the nomenclature has been of immense assistance in bringing a semblance of order into an almost hopelessly confused subject.

A few proteins had been previously prepared in crystallized form by other investigators. Dr. Osborne crystallized many of the seed globulins, and the readiness with which this could be done emphasized the fact that these proteins were definite substances entitled to the serious consideration of chemists.

The second phase of Dr. Osborne's work was initiated in 1899 with a paper[1] in which it was shown that the crystalline protein edestin from hemp seed forms two compounds with hydrochloric acid, a mono- and a di-hydrochloride, that the solubility of edestin in acid increases in direct ratio with the amount of acid present and that a number of crystallized vegetable globulins behave as bases neutralizing definite proportions of acid. In other words, the behavior of these proteins was that to be expected of basic substances of fixed composition. This was the end towards which his careful descriptive studies had been directed, a demonstration that proteins were definite chemical individuals. The position here taken was strengthened by later papers in which it was shown that proteins in general behave towards acid like bases, that they form salts both with acids and with alkalies and show many evidences of a capacity to undergo electrolytic dissociation and enter into ionic reactions.

These results emphasized the desirability of more complete chemical characterizations of the different proteins. The development of the methods of analysis of proteins at the hands of Hausmann, of Kossel and of Fischer furnished powerful means for supply[ing] this and full advantage was taken of them. Furth[er]more, determinations of physical properties such [as] specific rotation, the heat of combustion and solubil[ity] in saline solutions contributed materially to the so[lu]tion of the problem.

By 1908, when the paper on "The Different Fo[rms] of Nitrogen in Proteins,"[2] perhaps Dr. Osborne['s] most widely quoted contribution, appeared, data h[ad] been accumulated which indicated clearly that [the] proteins had been obtained that could not be co[m]pletely characterized by the methods of amino a[cid] analysis, coupled with a study of the physical pr[op]erties.

Beginning in 1906 and continuing for about [...] years, Dr. Osborne, with the aid of a number of c[ol]laborators, carried out a series of analyses of t[he] amino acid composition of proteins by the Fisch[er] ester distillation method. These studies set a stan[d]ard for such work which has been surpassed o[nly] since the introduction in recent years of greatly i[m]proved methods for dealing with certain of the ami[no] acids. Characteristically, he returned again a[nd] again to the analysis of a few of the proteins, such [as] casein, gliadin and zein, which possess special e[co]nomic importance, each time increasing the summ[a]tion of the components by the use of more refin[ed] technique. These analyses laid the foundation for t[he] extensive studies of the nutritive properties of pr[o]teins that were begun in collaboration with Profess[or] Lafayette B. Mendel, of Yale University, in 1909 a[nd] continued until 1928. This aspect of protein che[m]istry had attracted Dr. Osborne's interest from t[he] earlier part of his career; but he had realized th[at] until pure and uniform material could be obtained [in] abundance and its composition established by che[m]ical analysis, an investigation of the comparative n[u]tritive properties of proteins was useless. The stri[k]ing differences which now became evident in the co[m]position of many of the proteins suggested that th[eir] biological values might be correspondingly unlike.

It may be worth while to point out that in 1911 t[he] notion that proteins might differ widely in nutriti[ve] value was relatively new. The chemical metho[ds] showed that wide differences in amino acid make-[up] occurred and, where these failed, the anaphylactoge[nic] relationships, which had been studied in collaborati[on] with Professor H. Gideon Wells, of Chicago, emph[a]sized the difference in all save a few remarkable cas[es]. But where wide chemical differences occurred, as b[e]tween edestin and casein, both of which were found [to] be adequate for growth, it became necessary to su[p]pose that the animal organism is capable of effecti[ng]

[1] T. B. Osborne, *J. Am. Chem. Soc.*, 1899, 21: 486.

[2] T. B. Osborne, C. S. Leavenworth and C. A. Bra[utecht]lecht, *Am. J. Physiol.*, 1908, 23: 180.

r more elaborate and extensive chemical transformans than had generally been thought.

The investigation of the nutritive properties of the oteins involved the development of a technique for eding individual small animals which would permit curate measurements of the food intake. This was ccessfully accomplished, but the first experiments in hich the pure isolated proteins were fed, together ith sugar, starch, lard and an inorganic salt mixre, showed that normal growth of young animals d not take place, although mature animals, as well young, could be maintained for considerable peods. Growth of young animals could readily be cured when dried whole milk powder was furnished gether with starch and lard. This appeared to inicate that milk contained something other than proin essential for growth. The preliminary assumpon was made that the missing factor might be suplied by the inorganic constituents of the milk, and it as found that excellent growth could be secured hen evaporated milk serum from which casein and ctalbumin had been removed, the so-called "proteinee milk," was added in sufficient amounts to a diet f isolated protein, starch and lard. With the asistance of this material an extensive investigation evealed wide differences in the alimentation of aniials on different proteins. Animals rapidly failed on ein and gelatin, were maintained on hordein, rye and heat gliadin, but grew well on edestin, wheat glunin, lactalbumin or casein. Further work showed hat the failure of animals on a zein diet was due to he lack of tryptophane and lysine in this protein. When these amino acids were supplied growth ocurred. Similarly, gliadin could be made adequate or growth by an addition of lysine in which this proein was conspicuously deficient.

The use of protein-free milk in diets was attended y certain difficulties. It was not entirely free from itrogen and it could not be successfully replaced by n artificial mixture of salts made to imitate the composition of milk ash as closely as possible. Furthernore, animals nourished on this diet over long periods ltimately ceased to grow and declined rapidly in weight. In every case such animals could be brought o a normal rate of growth by changing to a diet conaining whole milk powder, and the ultimate failure n protein-free milk could be postponed or averted y feeding whole milk powder for occasional short intervals. An examination of the composition of the wo types of food revealed that the most conspicuous difference lay in the presence of milk fat in the dried milk food. Experiment soon showed that the addiion of butter to a casein, starch and protein-free milk diet sufficed to permit normal growth to maturity. When butter was added to a diet of dried skim milk upon which it had been found that animals ultimately failed, complete realimentation occurred.

These results were published in 1913. The paper describing them was submitted to the *Journal of Biological Chemistry* about three weeks after a paper by McCollum and Davis in which similar results, secured by the use of an ether extract of egg yolk and of butter, were described. The observations indicated that a substance occurs in butter which is essential for animal growth. This substance was later designated as vitamin A.

In the following year the important observation was made that the same stimulation of growth could be secured by the addition of cod-liver oil to a diet of purified food substances and protein-free milk, a discovery which served to focus attention upon the value of this oil, in particular as a curative agent for the peculiar eye condition known as xerophthalmia that was regularly encountered by Osborne and Mendel in animals on the deficient diets. At the close of the war the sight of many children in Europe was preserved by its use, a remarkable example of the application of scientific results to practical problems.

The later extensive contributions of Dr. Osborne and his associates to the science of nutrition can only be indicated. Much labor was devoted to the study of the nutritive value of the proteins of the commercially important foods and this work gave a rational explanation of many practices which empirical experience had shown to be advantageous. The distribution of vitamins A and B in natural food products was studied and considerable success was attained in an effort to prepare a vitamin rich concentrate from yeast. The phenomena of growth, its suppression and acceleration under various regimens, the effect of the individual inorganic constituents of the diet, these and many other topics received attention at different times.

The remarkable influence of minute traces of certain organic substances, the presence or absence of which in the diet determine success or failure of nutrition, drew attention to the importance of an investigation of the constituents of living cells. This led to a detailed study of extracts of the alfalfa plant and of yeast, both of which are valuable sources of vitamins. Much of the information secured did not reach the stage of publication, but a striking demonstration was obtained of the complexity of the chemical environment in which the life process takes place.

It would be incorrect to assume that Dr. Osborne's interest in the fundamental chemistry of proteins waned as he penetrated more deeply into the mysteries of animal nutrition. Innumerable chemical problems arose as a result of the feeding work and demanded solution. Such, for example, was the discovery in 1913 of lysine among the products of hy-

drolysis of gliadin: its presence had escaped the notice of previous observers, including himself. A study of the constituents of milk in 1917 revealed a new protein soluble in diluted alcohol, the first animal protein possessing this property to be found. Its anaphylactogenic relationships were worked out in collaboration with Professor Wells in 1921, and it was demonstrated to be distinct from the other three proteins of milk.

Dr. Osborne made a fundamental contribution to the chemistry of nucleic acids in 1900, when he announced the discovery of tritico-nucleic acid in the wheat embryo and observed that this substance yielded the purines, guanine and adenine, in molecular proportions. Subsequently he made it clear that the various nucleoproteins which could be prepared from the wheat embryo were in reality salt-like compounds of one and the same protein with variable proportions of nucleic acid. Generalizing from these observations he pointed out that the numerous nucleoproteins from animal sources that had been described were, very probably, also salt-like compounds of protein with nucleic acid.

Although all the preparation work and much of the chemical investigation of the proteins was done before the modern conceptions of acidity had been advanced, Dr. Osborne was aware of the influence of different degrees of acidity on his preparations. One of his early papers on the effect of small amounts of acid on edestin[3] contains the phrase "the concentration of the hydrogen ions in the solution," and it was his custom invariably to state the indicator which he used. It was not sufficient to neutralize a solution; the solution was neutralized to phenolphthalein, or litmus, or tropeolin, as the case might be, and the differences in behavior so indicated were fully appreciated. It is this meticulous attention to detail which gives Dr. Osborne's early work a value to the present-day physical chemist and renders it possible to furnish an interpretation in terms of modern theory, as has recently been done by Cohn.

Dr. Osborne was one of the most distinguished pupils of Professor S. W. Johnson, and through him traced his intellectual ancestry back to Liebig, the founder of agricultural chemistry. A painstaking, careful investigator who spared no effort, time or expense in the attainment of the truth, Dr. Osborne accepted no result until it had been subjected to the test of rigorous and repeated experiment and all his publications bear the marks of meticulous editing, lest a statement should to the slightest extent pass the bounds of ascertained fact.

[3] T. B. Osborne, *Ztschr. f. Physiol. Chem.*, 1901, 33: 225.

To those who were privileged to be associated with him in his work he was a rare stimulus, a formidable opponent in argument and an ever genial but just critic. He frequently closed a discussion with the remark that facts were to be found in the laboratory, not in the books. Naturally shy and retiring, the delivery of a public address or of a paper was a severe trial to which he looked forward with trepidation. But among a small group of friends he showed himself as a gifted conversationalist, who was equally able to discuss the latest achievements of science, the current political situation, the intricacies of the world of finance or the faults of the modern educational system.

The first public recognition of Dr. Osborne's exhaustive work came from Germany. V. Griessmayer, in 1897, published a book on vegetable proteins that contained many extracts from Dr. Osborne's papers and stated in the introduction that it was his object "to bring to light these treasures buried in their American publications." This encouragement, at a time when few of his associates or scientific friends had any conception of what his work meant, was of great assistance to him.

In 1900 he was awarded a gold medal by the Paris Exposition. In 1910 recognition came from Yale University in the form of the honorary degree of Sc.D., and in the same year he was elected a member of the National Academy of Sciences. Two years later he was made an honorary fellow of the London Chemical Society, and in 1914 he was made a fellow of the American Academy of Arts and Sciences.

In 1922 he received the John Scott medal and in the following year was made a research associate in biochemistry of Yale University with professorial rank. In 1928 he was the first to receive the Thomas Burr Osborne gold medal founded by the American Association of Cereal Chemists in recognition of his outstanding contributions to cereal chemistry.

Dr. Osborne's extensive investigations would have been impossible without generous financial support and encouragement. Throughout the early years, when results came slowly and their application was by no means apparent, the directors of the Connecticut Agricultural Experiment Station, in the early years Professor S. W. Johnson, and after 1900, Dr. E. H. Jenkins, with the cooperation of an enlightened board of control, allowed no interference or distraction to hinder the progress of the work. Since 1904 a large proportion of the financial burden has been borne by the Carnegie Institution of Washington, D. C., of which he was a research associate. Dr. Osborne's connections with both the experiment station and the Carnegie Institution of Washington furnish a

striking example of the value to science of a policy of non-interference on the part of those in control of the distribution of funds for research. Except for routine annual reports he was never asked for statements of progress or for outlines of projects. The relationship was always one of the utmost mutual confidence and esteem.

The results of Dr. Osborne's investigations were summarized in a monograph, "The Vegetable Proteins," which first appeared in 1909 and was extensively revised in 1924. This slim volume has become the classical publication in the field. His extensive studies of wheat proteins were reviewed in "The Proteins of the Wheat Kernel" (1907), now a standard text among cereal chemists. Including these and a few public addresses and popular articles a complete bibliography of his publications reaches 253 titles, of which about two hundred are journal reports of his personal scientific work.

Dr. Osborne's most marked characteristic was, perhaps, the thoroughness with which his problems were investigated. In the early preparation work each protein was isolated in as many different ways as possible, the composition finally ascribed to it was deduced from a large number of carefully conducted analyses and, where the economic importance of the protein warranted it, he returned again and again to its study. The wheat and maize prolamins received extraordinary attention and the methods of preparing even these well-known substances were recently, with the aid of his assistants, materially improved. Time and again he discarded the whole of his painfully acquired results to make a fresh start, this time to "do it right," as he expressed it. His death removes one of the great pioneers of American biochemistry, a man whose name will always be linked with the subject he made peculiarly his own. He was more fortunate than most men in that advancing years, distinctions and scientific recognition did not bring with them administrative responsibilities that deprived him of the opportunity to share in the daily work of the laboratory. His time was always freely available for discussion, not only with his associates, but with the innumerable investigators from all parts of the world who came to New Haven to see him and ask for advice. Ever kindly and courteous, with keen insight into the problems of others and an extraordinary wealth of experience upon which to form his judgments, he has left a memory that will long be treasured by those who had the privilege of knowing him.

HUBERT B. VICKERY
CONNECTICUT AGRICULTURAL EXPERIMENT STATION
LAFAYETTE B. MENDEL
YALE UNIVERSITY

THE OBJECTIVES OF UNDERGRADUATE COURSES IN PHYSICS FOR ENGINEERING STUDENTS[1]

FREEING myself, for a moment, from the restrictions implied by the above title, I wish to make some general observations concerning what seem to me to be the two superlatively remarkable aspects of present-day physical science.

(A) The first aspect relates to *the ability of the trained physicist to hold things in mind.* The clear and sharp concepts of the kinetic theory of gases, for example, constitute an actual working model of a gas, a working model which exists in one's head! And every physicist knows how this model helps one to hold gas-facts in mind and how tremendously it helps one to think about gas-facts.

Helmholtz, in commenting on the postulated or assumed elements which enter so largely into our conceptions of physical conditions and things, goes on to say "it is nevertheless a great help if we form in every case the most concrete possible picture, even when the picture contains many an assumption that is not, in all strictness, necessary."

(B) The second aspect relates to *the extent to which quantitative mathematics can be tied to physical conditions and things.* Every quantitative notion in physics *is* or *grows out of* a precise idea. Thus velocity is a precise idea; acceleration is a precise idea; electric current strength is a precise idea. In tying mathematics to physics nothing else is so essential as precise ideas, and it is an extremely remarkable fact that "the possession of precise ideas opens the mind," as Whewell has said, "to an almost endless array of simple perceptions which would be, without the use of precise ideas, non-existent."

Regarding these two things (A) and (B), I believe the time will come when every man who has to deal with physical things will have to be equipped with all of the more important concepts and with all of the more important precise ideas of physics, and trained to use these concepts and ideas effectively.

However remote the realization of this ideal for all working men may be, it is certainly now the main objective of the teaching of physics in the college and the engineering school; and, although the teacher of physics in the college can, perhaps, neglect this objective to some extent, the teacher of physics in the engineering school can not neglect it at all, and it is an objective which holds in the preparation of young men for research, even more rigorously, than in the preparation of young men for practical work.

[1] A paper read before the Summer Conference of Teachers of Physics to Engineering Students, Massachusetts Institute of Technology, July 13, 1928.

Every one will, I believe, admit that the main objective of physics teaching in the college and engineering school is *training in analytical thinking* as stated above, and my own conviction is that this objective is so all-important that nothing else need be mentioned in a consideration of the objectives of physics teaching. But it must be analytical thinking which relates to actual physical conditions and things, and every physics teacher should therefore give heed to Bacon's admonition as to method. "Our method," says Bacon, "is to dwell among things soberly, without abstracting or setting the mind farther from them than makes their images meet; and the capital precept for the whole undertaking is that the eye of the mind be never taken off from things themselves, but receive their images as they truly are; and God forbid that we should ever offer the dreams of fancy as a model of the world."

I. The Traditive Lamp

Bacon, in listing the needs of his time, made a quaint statement of one great need, namely, "A Traditive Lamp, or a Proper Method of Handing Down the Sciences to Posterity." Would that we knew the proper method now, after three hundred years! But we do not know the proper method, meaning, of course, the best possible method. Our traditive lamp is at best but a smoky contraption which is not sufficiently guarded, as a good lamp should be, against the uncertain winds of personal whim and fancy among teachers who lack a complete discipline in their chosen field of science. The greatest problem in teaching is the teacher.

II. What Faculty is of Greatest Importance in the Student of Physics?

One hundred and fifty years ago Pascal made the statement that the only faculty needed in the student if one is to be able to implant precise ideas and fundamental principles in his mind is eyesight; but, as Pascal says, it must be good eyesight because precise ideas and principles are so minute.

To illustrate Pascal's meaning let us consider what is perhaps the most important principle in physics, the principle of work: (*a*) When a body on which a force acts moves in the direction of the force, the force does work, and (*b*) the amount of work done in any given time is equal to Fd where F is the force and d is the distance the body (on which F acts) has moved in the direction of F. To make Pascal's meaning clear let us consider two common statements of part *a* and one common statement of part *b* of the above definition, for, of course, it is a definition.

(*a'*) A force does work when it overcomes resistance.

(*a''*) A force does work when it moves a body.

(*b'*) The work done by a force is found by multiplying the force by the distance through which it acts.

Regarding a': What do you mean by resistance? Did you ever see resistance? Did you ever feel a resistance. For of course when Pascal asks us to "see" a thing he means that we are to apprehend that thing by the senses. Now resistance has nothing whatever to do with the work done by a force F while the body on which F acts moves d feet in the direction of F, although resistance does have much to do with what becomes of the work done. When I pull on a body I have a definite muscular sense of the pull, or, in other words, I "see" the pull, and if the body moves in the direction of the pull I do work. It is wholly unnecessary and hopelessly confusing to introduce the word resistance into the definition of work.

Regarding a'': What do you mean when you say that a force "moves" a body? Do you not know that one of the most troublesome of misconceptions when we begin the study of dynamics is the mistaken idea that the effect of an unbalanced force is to "move" a body? No, the effect of an unbalanced force is to accelerate a body; after a time the body will be in motion, and after another time, as it were, the body will have traveled a certain distance. The double reference to elapsed time in this statement is a very crude and incomplete verbal equivalent for the square of the time in the familiar formula $d=\frac{1}{2}at^2$.

But let us point out another absurdity in statement *a''*. Imagine a mouse and an elephant hitched up as a team and drawing a cart. The mouse of course does work because she pulls on the cart which is moving in the direction in which she pulls, but it would show scant respect for the elephant to say that the mouse does work because she "moves" the cart.

Regarding b': The essential absence of meaning of this statement is illustrated by the answer given to the following problem by about 35 per cent. of a group of engineering students studying elementary mechanics in an engineering school. "A 10-foot rope is tied to a post and the post is pulled by a 50-pound force applied to the end of the rope. How much work is done?" The 35 per cent. above mentioned calculated the work as 500 foot-pounds, because, as they sensed the problem, the 50-pound force certainly "acts through a distance of ten feet."

Forces are things to be "seen": As another example of Pascal's meaning let us consider the idea of force, and let us remember that in every case in simple mechanics a force is exerted on a body by something which is tied to the body and pulls on it, or by something that butts against the body and pushes on it, excepting only the pull of gravity. No one ever saw

the "rope" through which the gravity pull of the earth is transmitted to and applied on a body. We have to get into the habit of merely admitting the existence of the gravity pull as one of the forces acting on a body. Of course we are not here concerned with magnetic or electric forces which are like gravity in that their "ropes" are invisible. But how about other forces, how are they to be recognized? The answer is "look—see." A ball is tied to a string and twirled in a circle. What forces act on the ball? Gravity, of course, exerts a downward pull on the ball, the string pulls on the ball, and the air in sweeping past the moving ball exerts a force on the ball, but no other force whatever is acting on the ball. Neglecting gravity and air friction the pull of the string is the only force acting on the ball. If you don't believe it look and see!

III. The Stuff out of Which Precise Ideas and Concepts Are Made

Precise ideas and fundamental principles, as they are held in the mind, are framed out of sense material, and the truth of what Pascal says about good eyesight as the one essential faculty in the student of physics could be illustrated by many examples in every phase of every branch of physics. Disregarding for the moment the small amount of what may be called word-philosophy which must underlie the discussion of any topic and disregarding for the moment the occasional necessity of explaining a purely mathematical point, *every statement that is made to a beginning student in physics should involve a vivid appeal to sense and to intuition.* I have come to accept this as my rule of procedure in the teaching of elementary physics, and, in my opinion, this rule can not be challenged. To follow this rule one must always be highly specific, one must always have in mind one particular physical condition or thing. One can not follow this rule and indulge in the fallacious procedure which is too commonly followed among teachers of physics, namely, the indulging in premature and meaningless generalizations which overwhelm all sense and bury all meaning.

IV. The Building Up of Precise Ideas and Conceptions by Definition

What is a definition in physics? How would you define a cow pasture? I would advise you, if you would wish the cow to pay any attention to your definition, to define the pasture or fix its boundaries, by building a fence around it! This may seem to be mere cheap humor, but it is not humor, it is physics! Every statement of principle and every definition in physics are actual operations, things done by the hand, when you really come to fathom their meaning; but in very many cases they are such complicated operations that they have to be highly idealized to avoid endless and confusing circumlocutions in specifying them.

Take, for example, the first law of thermodynamics which defines heat as a form of energy. How are we to reduce the statement of this principle to a specification of things done and yet have the things done and our conclusion as to the unvarying result sufficiently general to touch so wide a generalization as the first law of thermodynamics? It is not very difficult to do this, although, of course, when speaking of things done with the hands one should talk partly by hand, and I do not mean by this that a definite experiment be carried out—most assuredly I do not!

Take a body A and produce a definite change in its thermal condition (as indicated, for example, by a thermometer) by doing a certain amount of work on it, and then bring A back to its initial state by bringing it into contact with another cooler body B. Then it will be found that the thermal change produced in body B is exactly what would have been produced in B if the original amount of work had been expended on B directly. That is to say, body A by virtue of the change produced in it by the original work "contains something" which is exactly equivalent to the work in the restricted sense that A, in being brought back to its initial state, can produce exactly the same thermal change in body B as could be produced by the original work, and this "something" we call *heat*. The definition of heat as a form of energy is completely fixed by the specified result of the specified operation, and if you do not believe the result would be as stated, try the thing out. Only, of course, no laboratory man would advise you to try it out; it requires too many troublesome precautions to be sure that body A gives "heat" to no other body but B.

The most highly generalized statement of the principle of the conservation of energy is that "energy can be neither created nor destroyed," and this is a statement that no one can possibly understand although it is easy to make use of it in many physical problems without understanding it. If one wishes to know precisely what the statement means one must specify the underlying operations, and inasmuch as the first law of thermodynamics has been cleared up we need only consider the principle of the conservation of energy from the purely mechanical point of view.[2]

[2] This story occupies only two pages (68–70) of Franklin and MacNutt's "General Physics," McGraw-Hill Book Co., N. Y., 1916. It is, however, too long to reproduce here.

V. Mathematical Formulations and Mathematical Developments

The most vitally important parts of any physics text for beginners are the parts that are introductory to mathematical formulations; note that I say *mathematical formulations,* not *mathematical developments,* for it is the actual tying of mathematics to physics that is all-important. Mathematical developments *follow* mathematical formulations, and mathematical developments are easy.

Of course much use must be made of precise ideas and conceptions in the important business of reducing physics to mathematical forms, and what is said in Section III applies here also. The parts of a text that are introductory to mathematical formulations must be highly specific, they must have a vivid appeal to sense and to intuition, and they must be free from premature and meaningless (for the immediate purpose) generalizations. These vitally important parts of a physics text (which are introductory to mathematical formulations) are (a) often non-existent; (b) they are sometimes present in a text but rendered ineffective by premature generalizations, and (c) they are sometimes completely submerged and lost in elaborate mathematical developments. I could give extreme examples of all three cases, but I refrain from doing so.

Of all the generalizations of physics the principle of the conservation of energy and the closely associated ideas of energy transformation lend themselves most easily to verbal discussion, and in my opinion purely verbal allusions to energy conservation and energy transformations make for unintelligibility more than anything else in elementary physics discussions. Physics is, after all, *mechanism,* and if you do not "look at" the mechanism you get nowhere.

VI. Real and Adventitious Difficulties Encountered by the Student of Physics

Professor P. G. Tait says in the preface to his small book on heat that "the student who expects to find this book, elementary though it is, everywhere easy reading will be deservedly disappointed. No branch of science is without real difficulties even in its elements."

This is certainly true, but many elementary analytical texts are unnecessarily difficult, and the unnecessary difficulties are nearly always due to unintelligibility. The student does not "see" what the author is talking about. One must talk sense if one is to build up precise ideas and conceptions; one must talk sense if one is to establish mathematical formulations; one must talk sense if one is to lead a student to apply to a new problem the precise ideas and concepts that already exist in his mind; and, however far a student is carried forward in his analytical studies, one must continue to dwell among things without abstracting or setting the mind farther from them than makes their images meet.

VII. The Arousing of Interest among Students of Physics

I know from experience that most of our students like physics when the teaching is directed insistently towards the development and use of precise ideas or towards what may be called training in analytical thinking; and I know that our students can be carried far in this mildly difficult but highly profitable business. In fact I have always found my students to be so eager and enthusiastic that I could not wish them to be more eager or more enthusiastic.

In my opinion and according to my experience interest in the study of physics is *not* dependent upon the introduction of descriptive physics or on the application of any of the principles to practical engineering problems except of the simplest and most familiar kind; an almost purely analytical course in elementary physics arouses intense interest if one heeds Bacon's admonition and connects every detail of analytical method with actual conditions and things. The greatest fault of an earnest, hard-working teacher is to be exacting—and unintelligible.

VIII. The Objective of Undergraduate Courses in Physics for Engineering Students

Every good musical composition is supposed always to come back at the end to the initial chord, and I end this brief discussion after the canons of musical art, changing only the plural *objectives* to the singular form. The only objective worth talking about is training in analytical thinking. Increase of our powers of thought is the greatest gift of the sciences to mankind.

William S. Franklin

Department of Physics,
Massachusetts Institute of Technology

SCIENTIFIC EVENTS

INCREASE OF NATIONAL FOREST UNITS

Plans for the acquisition of 9,600,000 acres of land in accordance with the general program of national-forest purchases are being completed, according to an oral statement made by L. F. Kneipp, Assistant Forester in charge of the branch of lands of the Forest Service, and reported in the *U. S. Daily.*

Mr. Kneipp pointed out that the areas for purchase are approved by the National Forest Reserva-

on Commission and the lands are bought by the orest Service of the Department of Agriculture. reas that have not yet been submitted for the approval of the commission include lands in Mississippi, entucky and eastern North Carolina.

Areas recently approved by the commission, which re being bought by the Forest Service, Mr. Kneipp plained, are 100,000 acres in southern Vermont, and reas near Lake City, Florida; in Wisconsin, the pper peninsula of Michigan, upper Minnesota, other arts of Michigan, Louisiana, and eastern South arolina, and privately-owned lands within the National Forests of Choctawhatchasee and Ocala, lorida.

The general program of national-forest purchases, ccording to the National Forest Reservation Commission, divides the 9,600,000 acres to be acquired into e following four subdivisions:

Consolidation of federal ownership within national-rest units heretofore approved by the commission, d situated on the headwaters of navigable streams; pproximate area to be acquired, 4,000,000 acres.

Establishment of necessary additional national-rest units for protection of headwaters of navigable reams and reduction of floods thereon; approximate area to be acquired, 2,000,000 acres.

Consolidation of federal ownership within national-rest units on watersheds of navigable streams herefore approved by the commission in Michigan and innesota, primarily to aid in timber production d demonstrate forestry practice; approximate area be acquired, 1,100,000 acres.

Creation of a limited number of additional national-rest units in southern pine region and northern ke States, primarily to aid in timber production d demonstrate forestry practice; approximate area be acquired, 2,500,000 acres.

NSTITUTE OF TROPICAL MEDICINE AT THE UNIVERSITY OF CALIFORNIA

TENTATIVE plans for the University of California stitute of Tropical Medicine have been announced the Hooper Foundation, research center of the dical school, providing for lectures in the summer 1930, according to a statement made by Dr. Alfred Reed, professor of tropical medicine.

The purpose of the new organization is threefold, . Reed explains. It will provide the only western nter for the treatment and study of tropical disses and for research in general problems of health d food preservation in the tropics or locally as a ult of conditions having their origin in the tropics. Research, public education and treatment of individuals suffering from tropical diseases are given as e three phases of work to be carried on.

Under research are included the practical problems of health and disease in tropical countries; the problems arising from shipping between the United States and tropical countries, both as regards cargo and the personnel of the ships, passengers and crew, and the problems presented by epidemics of tropical diseases such as meningitis, cholera, yellow fever, etc.

Under public education Dr. Reed lists four lines of endeavor. First, regular courses in tropical medicine for graduate physicians from every part of the world. Second, courses in tropical public health service for nurses going to tropical countries or on ships touching at tropical ports. Third, courses on tropical medicine for students in the University Medical School, as desired. Fourth, public instruction in tropical hygiene and public health through popular lectures and a course for prospective travelers, merchants, soldiers and others intending to visit tropical countries.

Under treatment of individuals is included all such treatment as can not well be taken care of elsewhere. It is thought that the university center will care for people in all parts of the west, as the next closest center for the treatment of tropical diseases is in Galveston. Another is in New Orleans, but the rest are on the Atlantic seaboard. None of them, Dr. Reed says, is as wide in scope as that planned for the University of California.

Concerning the shipping problems to be studied, San Francisco, Los Angeles and other Pacific Coast ports are unloading places for innumerable cargoes of tropical goods, from copra, oil, forest products and foodstuffs on down. This commerce not only offers a means of entry for tropical diseases and parasites of many kinds, but is itself often hampered by the action of parasites in cargoes *en route*. This is particularly true in the case of cargoes of foodstuffs, recent reports having been received of the spoilage of large cargoes of cocoa-beans by an insect parasite.

CENSUS OF MIGRATORY WATERFOWL

DATA on the bulk movement of migratory waterfowl, such as ducks, geese, swans and coots, during their spring and fall migration, and on the limited areas of their winter concentration, are being accumulated through waterfowl censuses under the leadership of the Biological Survey of the Department of Agriculture. This census taking, which was inaugurated about eighteen months ago, is carried on through the cooperation of about 3,500 volunteer observers.

The waterfowl are widely distributed at various seasons throughout North America. In order to get definite information regarding their occurrence, numbers and migratory movements, direct observations must be made at regular intervals at a great number

of stations throughout this enormous area. Each observer selects an area typical of waterfowl conditions in his general region, and agrees to count the birds there once a month on a date that is the same for all observers.

Some of these cooperators travel on foot or in rowboats; others use automobiles or motor boats. Wherever possible, the birds are actually counted, but where the numbers are too great for this, careful estimates are made and recorded.

In the United States twelve bureaus or major units of the federal government that have field men stationed in suitable localities are cooperating with the Biological Survey in the undertaking. In Canada the censuses are conducted, also cooperatively, through the office of the National Parks of Canada.

All states and provincial departments concerned with game administration are giving active cooperation, and in many instances the entire warden force is aiding in the work. Information obtained through these censuses helps to fix proper open seasons and bag limits.

It will be necessary to accumulate reports over a period of two or more years before a basis for calculations regarding possible increase or decrease in the waterfowl population can be established.

ANTHROPOLOGICAL SCHOLARSHIPS

The Laboratory of Anthropology at Santa Fe announces the award of the following field-training scholarships for the summer of 1929:

Ethnology: Fred B. Kniffen, University of California; Robert A. McKennon, Harvard University; Gordon McGregor, Harvard University; Haviland S. Mekeel, University of Chicago; Maurice A. Mook, Northwestern University.

Linguistics: Harry Hoijer, University of Chicago; Berard Haile, Catholic University; Victor E. Riste, University of Washington; William H. Sassaman, University of Chicago.

Archeology: Isabel T. Kelly, University of California; Eva M. Horner, University of Chicago; William B. Bowers, II, Harvard University; Ssu-Yung Liang, Harvard University; Frances E. Watkins, University of Denver.

Alternates have been appointed as follows: *Ethnology,* Vincent M. Petrullo, University of Pennsylvania; *Linguistics,* Robert B. Hitchman, University of Washington; *Archeology,* Owen S. J. Albert, University of Chicago.

The scholarships are designed to enable properly qualified graduate students who are preparing themselves for professional careers in anthropology to supplement, by practical work in the field, the classroom and laboratory instruction which they receive at the universities. Recipients of scholarships will take pa in the current investigations of experienced resear men; they will have opportunity to become famili with the use of modern field methods for the colle tion of data; they will gain experience in the inte pretation of these data and in their application to an thropological problems, specific and general. It i planned to offer, year by year, scholarships for wor in various branches of anthropology in various geo graphical areas.

The area for 1929 will be the southwestern part o the United States. Scholarships are offered for trai ing in archeology, ethnology and linguistics. Scho ars in archeology will be assigned to the excavatio of Phillips Academy, Andover, at Pecos, N. M., di rected by Dr. A. V. Kidder. Scholars in ethnolog will take part in studies of the Walapai of Arizon under direction of Professor A. L. Kroeber, of th University of California. Scholars in linguistics wi accompany the field party of the University of Ch cago, Professor E. Sapir in charge, to the Navah At the close of the field season scholars and inves gators will meet at Pecos for a week of discussion an the correlation of results.

For the fourteen scholarships available there we received thirty-eight applications from ten univers ties. Of these, fifteen were for archeology, eighte for ethnology and five for linguistics; twenty-sev from men, eleven from women. The quality of t candidates was, in most cases, so high that great dif culty was encountered in making selection.

Certain principles were adhered to by the commi tee: (1) That as the scholarships are expressly d signed for students who have lacked opportunity f work in the field, applications from persons who ha had such opportunity should this year be refuse (2) That students who are only to receive their A. degree in June, 1929, should, other things being equ be ranked below those who have already had one two years of graduate work. (3) That as there a at present open to women relatively few profession positions in anthropology, the number of scholarshi granted to women should be limited. Furthermor the conditions under which the investigations a being carried on during the summer of 1929 preclu the assignment of women to the ethnological and li guistic parties. Women, therefore, were assign only to the archeological party, but it is hoped arrange the field work in future years in such a w as to permit all properly qualified women students have at least one season as a scholarship holder du ing the course of their graduate school work.

Fay-Cooper Cole,
R. B. Dixon,
A. V. Kidder, *Chairman*

UMMER MEETINGS OF THE BOTANICAL SOCIETY OF AMERICA

In accordance with the sentiment expressed by the embers in a recent poll, the Botanical Society of merica will conduct two summer meetings during the resent year. One of these will be held at Dartmouth ollege, Hanover, N. H., beginning on the evening of une 25 and extending through June 28, and the other the mountain camp of the University of Wyoming om July 31 to August 3.

These meetings are not to be patterned after the gular winter meetings, where emphasis is placed pon the presentation of the results of research in rmal papers. They will be characterized rather by formality, the time being devoted to field excursions d round-table discussions. Everything will be done promote that personal association out-of-doors hich is necessarily lacking at the more formal and owded meetings.

At the Dartmouth meeting it is planned to have an ldress of general botanical interest and an informal ception on the opening evening, a number of morng round-table discussions of special topics, two fternoon field trips, one all-day field excursion, and open discussion of botanical teaching methods.

Registration for the Wyoming meeting will occur at aramie on the afternoon of July 31; this will be folwed by an informal dinner and reception. On the llowing morning those in attendance will be taken automobile to the mountain camp, where three days ll be occupied by field excursions and round-table scussions.

The chairman of the Pacific Section of the Botanical ociety of America has extended an invitation to embers of the society and others to consider the nual meeting of the section, to be held in June, as nother summer meeting of the society.

A cordial invitation to attend the meetings is exnded to botanists who are not members of the soety, and especially to those who may be visiting is country from abroad.

A circular containing more detailed information will mailed to every member of the society in May. eanwhile inquiries may be addressed to the undergned or to the chairmen of the local committees: rofessor A. H. Chivers, Dartmouth College, Hanover, . H., and Professor Aven Nelson, University of yoming, Laramie, Wyoming.

L. W. Sharp, *Chairman of the Organizing Committee*

Cornell University,
Ithaca, N. Y.

SCIENTIFIC NOTES AND NEWS

The fiftieth anniversary of the birth of Professor lbert Einstein will be celebrated on the evening of April 16 at the Metropolitan Opera House in New York City, under the auspices of the Jewish National Fund and the Zionist Organization of America. Professor Einstein has submitted to the Prussian Academy of Sciences a further paper which according to press despatches is entitled "A Unitary Field Theory and the Hamilton Principle." The manuscript of the preceding paper on the new field theory has been presented to the Olin Library of Wesleyan University by George W. Davison, president of the board of trustees, and Mr. Albert W. Johnson.

M. J. Richard, director of the Museum of Oceanography at Monaco, has been elected a correspondent of the Paris Academy of Sciences to take the place of Roald Amundsen. Guido Castelnuovo, professor of mathematics at Rome, has been elected correspondent in place of the late Luigi Bianchi.

On the occasion of his sixtieth birthday the State University of Moravia in Brno has conferred on Dr. Aleš Hrdlička, of the U. S. National Museum, the honorary title of "doctor of natural sciences."

At the graduation exercises of the Yeshiva College, New York, held in its new building on April 2, the degree of doctor of literature was bestowed upon Dr. David I. Macht, lecturer in pharmacology in the Johns Hopkins University and director of the Pharmacological Laboratory of Hynson, Westcott and Dunning, in recognition of his scientific investigations concerning the materia medica, pharmacology and hygiene of the ancient Hebrews.

Lieutenant-Commander C. H. Havill, chief of the propeller section of the Navy Bureau of Aeronautics, has been notified by the Society of Automotive Engineers that he has been awarded the Wright Brothers' medal for his paper entitled "Aircraft Propellers."

Professor I. A. Abt, of Chicago, has been elected an honorary member of the German Society for Children's Diseases.

Professor J. W. Gregory has been elected president of the Geological Society of London. The vice-presidents are Dr. F. A. Bather, Professor E. J. Garwood, Dr. E. Greenly and Mr. H. W. Monckton.

The *British Medical Journal* states that the Gifford Edmonds prize in ophthalmology has been awarded to Mr. V. M. Métivier, of the Ophthalmic Department of the Edinburgh Royal Infirmary, for his essay on the causation and differential diagnosis of proptosis. This prize, founded by Miss Sophie Edmonds in memory of her brother who fell at Magersfontein, is valued at £100, and is awarded every second year.

According to *Nature* the proceeds of the Daniel-Pidgeon Fund for the year 1929 of the Geological

Society of London have been awarded to Mr. J. Selwyn Turner, who proposes to investigate the faunal succession in the Coomhoola Grits and Carboniferous Slate of County Cork.

Professor Hayashi, dean of the medical faculty of Tokio, has been elected an honorary member of the Therapeutical Society of Paris.

At the recent annual meeting in Chicago of the Board of Trustees of the American Medical Association, Dr. J. W. Churchman, professor of experimental therapeutics in the Cornell Medical College, was selected to represent the American Medical Association on the Commission on Standardization of Biological Stains, and at the recent meeting of the commission in Rochester was elected a member of its executive committee. The latter consists of representatives of six national scientific societies (Society of American Bacteriologists; Botanical Society of America; American Chemical Society; American Association of Pathologists and Bacteriologists; American Society of Zoologists and the American Medical Association). The Stain Commission, of which Dr. Churchman has been a member since its formation several years ago, is responsible for the standardization of stains used in the sciences, and the duties of the executive committee include the editorship of the journal, *Stain Technology*, in which are published scientific articles in this field.

At the First International Congress on Sanitary Aviation to take place in Paris from May 15 to 20 observers appointed on the part of the United States include: Assistant Surgeon-General Rupert Blue, U. S. Public Health Service; Lewis H. Bauer, medical director of the Aeronautics Branch of the Department of Commerce; Lieutenant-Commander William D. Thomas, assistant naval attaché for aviation, American Embassy, Paris; Major Barton K. Yount, assistant military attaché for air, American Embassy, Paris.

The National Research Council has appointed as its representatives at the Fourth Pacific Science Congress in Batavia and Bandoeng, Java, which will be held from May 16 to 25, Dr. Herbert E. Gregory, of Yale University, director of the Bishop Museum, Honolulu; Dr. Frederick V. Coville, Bureau of Plant Industry, Washington; Dr. Philip S. Smith, U. S. Geological Survey, Washington; Dr. Andrew C. Lawson, professor emeritus of geology and mineralogy, University of California, Berkeley, and Dr. T. Wayland Vaughan, director of the Scripps Institution of Oceanography, La Jolla, California.

Dr. Bailey Willis, emeritus professor of geology at Stanford University and research associate in seismology of the Carnegie Institution of Washington, now in London on his way to East Africa to make study of the earthquakes of that continent. He pla later to visit India, the Dutch East Indies and the Philippines.

The expedition headed by Mr. Gifford Pinchot h sailed from New York on a three-masted topsa schooner, to study the Galapagos and Pitcairn Islan in the Pacific. Members of the expedition include Dr. A. K. Fisher, naturalist from the National Mu seum; Dr. Henry A. Pilsbry, curator of the depar ment of invertebrates at the Philadelphia Academ of Natural Sciences; Dr. Thomas O. Otto, an Howard Cleaves, picture expert and lecturer. D Fisher's son, Dr. W. K. Fisher, head of the biologic department of Leland Stanford University, will jo the expedition at Panama. The party plans to sto first at the almost unknown Grand Cayman and Sw Islands in the Caribbean Sea and will then visit th Galapagos Islands. The party will then cruise for mo than 3,000 miles, going on to the Marquesas, Tahit Paumatu, Society, Cook, Friendly, Tubuai, Gambie Pitcairn and Easter Islands. Collections will be mad for the National Museum, the Carnegie Museum i Pittsburgh and the Philadelphia Academy of Science Additional work may be done for some universitie

Professor Edwin O. Jordan, of the University Chicago, spent February and March in the We Indies as visiting professor to the School of Tropic Medicine in San Juan. He delivered several address to the faculty and students of the School of Tropic Medicine and spoke on several occasions before se tions of the Porto Rico Medical Association. D Ernest E. Irons, dean of Rush Medical College, al visited the school during February and gave the several lectures before the Porto Rico Medical As ciation. Dr. Alwin M. Pappenheimer and Dr. F. W O'Connor, of the College of Physicians and Surgeon Columbia University, are spending the second semest as visiting professors and are offering courses i pathology and protozoology, respectively. Dr. O'Co nor is continuing his work on filariasis.

Professor R. E. Moritz, head of the departme of mathematics of the University of Washington, on leave of absence for the winter and spring qua ters of 1929. He is making a tour of the world, pr ceeding from Seattle to Japan, China, Dutch Indie Straits Settlements, India, Suez Canal, Souther Europe, France and back to New York and Seatt in time for the fall quarter. Professor A. F. Ca penter is acting as department head during Professo Moritz's absence.

Dr. Eugene L. Opie, of the University of Pennsy vania, will deliver the eighth Harvey Society lectu

the New York Academy of Medicine on April 18. is subject will be "The Pathogenesis and Transmis- on of Tuberculosis."

Dr. W. E. Garrey, head of the department of phys- logy at the school of medicine of Vanderbilt Uni- rsity, delivered one of the Mayo Foundation lec- res in Rochester, Minnesota, on the evening of arch 29. The subject of the lecture was "The Basal eucocyte Count and Physiological Leucocytoses."

Albert Brachet, professor of anatomy and em- yology in the University of Brussels and director of e institute of anatomy, lectured at Cornell Univer- y Medical College on February 18 and 20 on "Ac- vation and Fertilization of the Egg" and "Heredity an Embryologic Process."

On his return from Cairo, Egypt, Dr. J. E. Guber- , associate professor of zoology at the University Washington, delivered two lectures at the Kansas ate Agricultural College. On March 21, he ad- essed the Sigma Xi and the Science Club on the bject "Medicine and Public Health in Egypt, Past d Present," and on March 22, he lectured to the udents and faculty on "The Glory of the Nile."

Dr. Albert P. Mathews, professor of biochemistry the University of Cincinnati, will give a lecture on he Coagulation of the Blood" on April 23 under e auspices of the Sigma Xi Club of the University Alabama.

Professor Roswell C. Gibbs, of the department physics of Cornell University, who is president- neral of the national organization of Phi Kappa i, was the principal speaker at the initiation cere- onies at Syracuse University on March 6.

Dr. Robert A. Millikan, of the Norman Bridge boratory of the California Institute of Technology, ill give the commencement address at the Carnegie stitute of Technology, Pittsburgh, on June 11.

As a memorial to Dr. Bashford Dean, the present hibit of fossil fishes in the southeast rotunda on the urth floor of the American Museum of Natural His- ry, New York City, is being enlarged and perfected, d will be known hereafter as the Bashford Dean emorial Exhibit of Fossil Fishes. The work is in e hands of the Bashford Dean Memorial Committee, nsisting of J. Leroy Conel, Hawthorne Daniel, eveland Earl Dodge, William King Gregory (chair- an), Eugene Willis Gudger, Francesca La Monte ecretary-treasurer), John T. Nichols, Henry Fair- ld Osborn, Mrs. George W. Perkins, George H. erwood, Bertram Smith, Alexander McMillan elch. This committee is now engaged in having ade a bronze bas-relief tablet bearing a portrait of Dr. Dean, that is to be placed at the entrance to the exhibit.

A bronze memorial which will perpetuate the memory of Dr. Dudley Allen Sargent, professor of physical education at Harvard University and founder of the Sargent School in Cambridge, has been received at the school as a gift from the alumni association. The memorial was designed by Dr. R. Tait McKenzie, head of the department of physical education at the University of Pennsylvania. The memorial bears the inscription: "Dudley Allen Sargent—to keep in memory his life work." Figures of three girls and a boy at play complete the design. The bronze will be erected on the flagpole at the Sargent Camp, Peterboro, New Hampshire.

The death is announced of Cyril Guy Harrold, the Canadian naturalist. Mr. Harrold was on the eve of sailing as a member of the Madagascar Expedition, which the American Museum of Natural History is about to send in cooperation with the British Museum of Natural History and the Paris Museum of Natural History.

Nature reports the death at Moscow of Dr. G. S. Zaitzev, director of the Turkestan Plant Breeding Station; of Dr. J. E. Eddison, emeritus professor of medicine in the University of Leeds, and of Mr. Victor Plarr, librarian of the Royal College of Surgeons of England.

Applications for chemist and associate chemist must be on file with the Civil Service Commission at Washington, D. C., not later than May 14. The examinations are to fill vacancies in the Departmental Service, Washington, D. C., and in the field. The entrance salaries are $3,800 a year for chemist, and $3,200 a year for associate chemist. Higher-salaried positions are filled through promotion. The optional subjects are (1) advanced inorganic chemistry, (2) analytical chemistry, (3) organic chemistry, or (4) physical chemistry. Competitors will not be required to report for examination at any place, but will be rated on their education, training and experience, and a publication or thesis to be filed by the applicant. Full information may be obtained from the U. S. Civil Service Commission, Washington, D. C., or from the secretary of the U. S. Civil Service Board of Examiners at the post office or custom-house in any city.

The British Institute of Metals celebrated its twenty-first anniversary on March 13.

At the meeting of the New England Health Institute in Hartford, from April 22 to 26, a banquet will be given to celebrate the fiftieth year of the Connecticut State Department of Health. The speakers

will be Surgeon-General Hugh S. Cumming, U. S. Public Health Service; Dr. George E. Vincent, president of the Rockefeller Foundation; Dr. Edward K. Root, Hartford, and Governor Trumbull. The institute is sponsored by the Yale and Harvard Medical Schools, the New England State Departments of Health and the U. S. Public Health Service.

The American Association of Textile Chemists and Colorists has formed a special subcommittee of the committee on research, to prepare an annual bibliography on all phases of textile chemistry, dyeing, printing, bleaching, finishing, etc. The committee is at present composed of five members, with Chas. E. Mullin, chemistry and dyeing division of the Clemson College Textile School, as chairman.

Public lectures to be delivered under the auspices of the Carnegie Institute of Technology include a series of lectures by Dr. Arnold Sommerfeld, professor of theoretical physics at the University of Munich, which were given on the evenings of April 2, 3, 4 and 5 on "The New Quantum Statistics of the Electrons in Metals." Dr. William H. Steiner, associate professor of economics at the College of the City of New York, on April 11 and 12 discussed "Investment Trusts." The new Hudson River Bridge now being constructed at New York City is the subject of two lectures to be given on April 15 and 16. O. H. Ammann, chief engineer of bridges of the Port of New York Authority, lectures on "The History, Conception, Development and Design of the New Hudson River Bridge," and on "Construction of the New Hudson River Bridge," will be given by Edward W. Stearns, assistant to the chief engineer of bridges of the Port of New York Authority. Two lectures on "Hydraulic Experimentation," by Dr. Ing. Theodor Rehbock, professor of hydraulics at the Technische Hochschule of Karlsruhe, Germany, will be given on the evenings of April 18 and 19, and two lectures by Igor I. Sikorsky, of the Sikorsky Aviation Corporation, Long Island, on "Large Airliners of the Present and Near Future" and "The Amphibian Airplane" on May 8 and 9.

It is stated in *Nature* that, in accordance with the recommendations of the recent committee on the organization of a Colonial Agricultural Service and of the Colonial Veterinary Services Committee, the Secretary of State for the Colonies has appointed the following Colonial Advisory Council of Agriculture and Animal Health: Mr. W. Ormsby-Gore (temporarily chairman), Mr. F. A. Stockdale (vice-chairman), Lieutenant-General Sir William Furse, Dr. A. W. Hill, Dr. G. K. Marshall, Dr. E. J. Butler, Professor T. B. Wood, Dr. W. H. Andrews, Dr. A. T. Stanton and Mr. R. V. Vernon. The Lawes Trust Committee and the Joint Committee on Research in Animal Nutrition of the University of Aberdeen and the North of Scotland College of Agriculture, respectively, have been invited to give their consent to Sir John Russell and Dr. J. B. Orr serving on the council. Mr. G. H. Creasy, of the Colonial Office, has been appointed secretary to the council.

The New York Hospital and the Lying-In Hospital have agreed to merge and become a part of the project of the Society of the New York Hospital for teaching and research in the New York Hospital-Cornell Medical College Association. The agreement provides that about $8,000,000 will be available to build and carry on a maternity hospital, which will be part of the new plant of the society overlooking the East River between Sixty-eighth and Seventieth Streets. J. P. Morgan and the Laura Spelman Rockefeller Memorial have given $2,000,000 each toward the maternity hospital, and George F. Baker and George F. Baker, Jr., each $1,000,000, while the remaining $2,000,000 will come from the assets of the Lying-In Hospital. Graduate work for physicians and special training for nurses will be a feature of the work. Adjoining the maternity hospital of 160 beds will be a pediatric hospital of 150 beds. It will be about two years before the Lying-In Hospital is completed. The two institutions were closely associated as far back as 1801, when an arrangement was made to maintain the patients from the Lying-In Hospital in a ward in the New York Hospital, then on Broadway between Duane and Worth Streets. That arrangement continued until 1827.

The International Council for the Exploration of the Sea held its annual meeting this year in London. The council was founded in 1902 for the organization of international investigations of fisheries and oceanography. Fifteen countries are now represented on it—namely, Belgium, Denmark, France, Finland, Germany, Great Britain, Holland, the Irish Free State, Italy, Latvia, Norway, Poland, Portugal, Spain and Sweden. The headquarters of the council are in Copenhagen. The council last met in London in 1920, when it first reassembled after the war. It assembled on April 8, and after a brief session of the full council the committees set to work to discuss the progress of the past year and settle the program of work for the following year. The normal business of the council at its annual meeting was concluded on April 15, when a final meeting was held to approve the general program of work. Special meetings were held, by the courtesy of the Zoological Society of London, in the society's meeting rooms, for the discussion of the "Fluctuations of Fisheries and Methods of Measuring Currents." Before leaving England the council visited the station of the Marine Biological Association at Plymouth, and took part in a joint meeting there with the Challenger Society.

UNIVERSITY AND EDUCATIONAL NOTES

BEQUESTS amounting to about $700,000 to Princeton University, the University of Pennsylvania, the Presbyterian Hospital and Bryn Mawr Presbyterian Church are made in the will of Harold A. Freeman, a business man of Philadelphia.

A GIFT of $500,000 has been made to the Hill School in Pottstown, Pennsylvania, by Mrs. Alexander Hamilton Rice for a general science building as a memorial to her son, Harry Elkins Widener. In addition to the usual scientific facilities, the building will provide small private laboratories for the use of gifted students.

DR. A. G. BLACK, associate professor of agricultural economics at the University of Minnesota, will become head of the department of agricultural economics at the Iowa State College at Ames on July 1.

DR. E. G. CONDRA, head of the conservation and survey division of the University of Nebraska, has been appointed dean.

A. O. HICKSON, of Brown University, and E. R. C. Miler, of Rice Institute, have been elected assistant professors of mathematics at Duke University, effective September, 1929.

THE full Board of Curators of the University of Missouri on April 7 upheld the dismissal of Dr. Harmon O. DeGraff, assistant professor of sociology, for his part in the circulation of a sex questionnaire among students. It granted reinstatement to Dr. Max F. Meyer, professor of psychology, who, however, was ordered suspended for one year.

DISCUSSION

CRITERIA OF HYBRIDITY

CRITICISMS of certain phases of genetical research have from time to time been made in this journal and elsewhere on the ground that the material is "abnormal" or of hybrid nature. Leaving aside for the moment any wider considerations, it may be of interest to examine the value of the criteria of hybridity upon which the critics base their arguments.

Sterility, once thought to be a very good criterion of hybridity, is now admittedly a difficult one, owing to the possibility of confusion with incompatibility which in certain cases causes "self-sterility" and failure of matings between individuals genetically identical in respect of the incompatibility factors.

The more recently invoked criteria of hybridity are irregularities in the maturation division, or meiosis, and pollen sterility of plants. The former has been especially invoked by Professor Jeffrey against *Drosophila melanogaster* (SCIENCE, 62 (1592): 3–5, 1925; and *ibid.*, 68 (1758): 233–235, 1928). Professor Jeffrey first stresses the difference between the body-cell and the germ-cell divisions in hybrids. This difference, interesting as it is from the cytologist's point of view, is surely irrelevant when the issue is the determination of hybridity. With few exceptions the body-cell divisions are regular regardless of the "purity" or hybridity of the organism or of the character of its germ-cell divisions. A feature common to both hybrids or abnormal forms and to pure species can scarcely be of value as a criterion for distinguishing between them.

Irregularity of the maturation divisions is very frequently associated with a hybrid condition, but again it can not be accepted as a satisfactory criterion of hybridity. First, hybridization between distinct species may give offspring with regular maturation divisions, even though the hybrids are in some cases sterile; and secondly, irregularity of the maturation divisions can be brought about by agencies other than hybridization. A few instances may be cited in illustration of these points.

The cross *Primula floribunda* × *P. verticillata* produces the form known as *P. kewensis.* The immediate offspring of the cross are sterile diploid plants having the same chromosome number as each of the parents, *viz.*, eighteen, and they have apparently normal maturation divisions. In the fertile, practically true-breeding form of *P. kewensis,* which has arisen from the doubling of the chromosome number, the maturation divisions are relatively regular, though slightly less so than in the sterile diploid form (Digby, *Ann. Bot.*, 26: 357–388, 1912; and Newton and Pellew, *Jour. Genetics,* 20: 405–469, 1929). In passing, one may note the bearing of this case upon the relative importance of the parts played by hybridization and chromosome irregularity in the production of new forms. Hybridization directly produces the type form *P. kewensis,* chromosome doubling renders it fertile, and the occasional irregularities of the maturation divisions produce variant forms.

A number of animal species hybrids which have regular maturation divisions are also known. One recent and interesting example of these is the hybrid between *Metopsilus* (*Chaerocampa*) *porcellus* and *Chaerocampa elpenor* described by Federley (*Hereditas,* 9: 391–404).

Some personal cytological observations on aberrant tomatoes produced by my colleague, Mr. M. B. Crane, may serve to illustrate the point that abnormality of the maturation divisions may be produced by agencies other than hybridization. Normal tomato plants, having the diploid chromosome number twenty-four, were cut back and from the subsequently formed callus surface adventitious shoots arose, which mostly

had twenty-four chromosomes in their somatic cells, but in a number of cases had forty-eight, and in two instances had about thirty-six. The maturation divisions of these latter triploid plants are as "abnormal" as are those of triploids produced by hybridization.

Sudden chilling and other agencies have also been found to upset the regularity of meiosis, but these cases need not be described in detail.

An illustration involving an intermediate degree of irregularity may be drawn from oats and wheat. *Avena sativa* and *Triticum vulgare* each have forty-two chromosomes which form twenty-one pairs, and with only very rare exceptions behave normally at meiosis. Occasionally plants arise, presumably through one of the rare irregularities, which have only forty-one chromosomes. In these there is normal pairing and separation of forty of the chromosomes at meiosis and "abnormal" behavior of the odd chromosome. Such divisions of course give rise to many gametes with twenty chromosomes instead of the normal twenty-one, and the mating of these in self-fertilization produces dwarf plants with forty chromosomes. In these plants, however, the chromosome pairing is very erratic and the maturation divisions are extremely irregular (Huskins, *Jour. Genetics*, 18: 315–364, 1927; and *ibid.*, 20: 103–122, 1928).

Although cultivated wheat and oats are, in my opinion, almost certainly of hybrid origin, it can scarcely be argued that it is hybridity as such which is responsible for this difference in behavior between the immediate parents and their offspring produced by self-fertilization.

With reference to the criterion of pollen sterility, a case in Rubus is particularly interesting. This genus contains very many hybrid forms, and hybridity in it is often very closely *correlated* with pollen sterility. Yet in a cross made by Mr. M. B. Crane between *R. rusticanus inermis* and *R. thyrsiger*, one of the first generation offspring had very much better pollen than either of the species. Not only has the hybrid better pollen than its parents but its fertility and seed germination are also exceptionally high. The cytological and breeding behavior of this case is described in detail by Crane and Darlington, *Genetica*, 9: 241–276, 1927.

From these and many other instances it seems clear that it is not hybridity as such which causes irregularity at meiosis or pollen sterility, but rather that regularity depends upon a balanced condition which *either* hybridization *or* other agencies may or may not upset. The presence of two complete sets of homologous chromosomes seems to be the prime requisite for regularity of the maturation divisions, but this is a matter apart from the present issue. It seems clear that there is no one satisfactory criterion of "hybridity" in the commonly accepted sense of the term,[1] and that arguments based upon any one of the supposed criteria above mentioned must lack general validity.

Apart from the doubtful validity of the premises upon which criticisms of research on "hybrid" or "abnormal" forms have been based, the arguments in themselves are of very questionable value. The relative importance of hybridization, mutation or "abnormality" in species formation is still a matter of dispute. The significance of the term "hybrid" depends very largely on one's definition of a "species," and until we know more about what constitutes the normal, the charge of abnormality makes a precarious foundation for argument. The elucidation of these points is one of the primary objects of genetical and cytological research.

C. Leonard Huskins
John Innes Horticultural Institution,
London, S.W. 19

OBSERVATIONS ON THE SYNCHRONOUS FLASHING OF FIREFLIES IN SIAM

From time to time there have appeared in the pages of Science various references to the remarkable phenomenon exhibited by certain fireflies of flashing in unison. Both Dr. E. W. Gudger[1] and Dr. E. S. Morse[2] have reviewed the literature of the subject in a very thorough manner, and it would be quite outside the scope of this note to repeat their references.

During the course of a three-years' period of residence in Bangkok, it was possible to make some rather close observations on the nature of this synchronism and to determine in which respects the theories that have been advanced to explain the phenomenon fit the observed conditions.

The synchronism, as one finds it in the Far East undoubtedly is very different from that reported from this country.[3] In the Orient it is distinguished by the fact that it is quite a common occurrence in certain well-defined areas, and furthermore, in that it involves vast numbers of insects, neither of which conditions is usually observed in the synchronism reported from America. In fact, in the latter locality the phenomenon has apparently been of such unusualness as to call forth comment.

During the months of July, August, September, and until the heavy rains set in, on any dark night it is possible to see whole stretches of the river or canal

[1] It seems probable to the writer that many mutations, especially of polyploid plants, which are now commonly attributed to gene mutation, will be found to owe their origin to some physical nuclear aberration such as chromosome interchange, loss, or gain, or segmental duplication or deficiency. Since such aberrations produce only recombinations of existing factors, they might be classified as phenomena of "internal hybridization." This would, however, constitute a definition of hybridity beyond that in common acceptance.

[1] E. W. Gudger. Science, N. S., 50: 188 (1919).

[2] E. S. Morse. Science, N. S., 44: 169, 387 (1916); 59: 163 (1924).

[3] H. A. Allard. Science, N. S., 44: 710 (1916).

[...]nks lit up by the flashing of myriads of insects. [...]ese areas of synchronism may extend for several [...]ndred yards at a stretch or may be confined to [...]gle trees, glowing and being extinguished with [...]rprising regularity. Actual timing of this inter[...]ttence showed that luminescence occurs at the rate [...] approximately 120 times a minute.[4] During the [...]riod between the flashes the light of the fireflies [...]ached almost complete extinction, the intensity being [...] low that at a few feet from a tree of actively [...]minescing insects it is quite invisible.

Perhaps one of the first things which is called to [...]e attention of the observer is the fact that this [...]nchronism is confined to localities bordering on [...]reams, or to low, water-saturated ground. This [...]ct was first pointed out by the late Sir John Bower[...]g,[5] who made the significant observation that "they [...]ve their favourite trees." Around Bangkok it is [...]mmonly known that the synchronal flashing of fire[...]ies is confined to one particular tree, the "ton [...]mpoo" of the Siamese—*Sonneratia acida*. In all of [...]e observations which the writer has made, no excep[...]ons to this have been found, but whether this par[...]cular tree is the gathering-place of the insects in [...]ses of synchronism reported from other parts of the [...]ast is a question.

The fact that *Sonneratia acida* is the tree on which [...]e insects congregate around Bangkok leads one to [...]estion the statement that has been frequently made [...] the effect that the synchronal flashing of the fire[...]ies is a mating adaptation. *S. acida* is found both [...] mangrove associations, and also as a solitary tree [...]rowing along the banks of streams. In these latter [...]ses the roots of the tree are often immersed in [...]ater, the tree at times standing several feet from [...]he bank. If the females of the species are wingless, [...]s is the case with the majority of the North American *[...]ampyridae*, there would be no opportunity for them [...]o approach the tree. Furthermore, at no time have [...]emales been found on a tree of actively synchronizing [...]nsects, or within its vicinity. Observations on this [...]oint have been repeatedly made and have been cor[...]roborated by local entomologists who have become [...]nterested in the problem.

Among the various theories which have been ad[...]vanced to explain this concerted action on the part [...]f the fireflies is the effect of slight currents of air [...]n the position of the body, due to the occurrence of synchronism only when the insects are at rest on some tree. The belief has arisen that slight currents of wind might so change the position of the body that the luminous organ would be exposed for a short period of time, only to be covered again when the body was allowed to return to its former position. Synchronism has been noted not only on nights when there was absolutely no wind, but also on quite windy nights.

Perhaps one of the most popular theories is that of "sympathy." According to this idea there is some particular insect which acts as a pace-maker for the rest, and they follow him, regulating their flashes by his. However, due to the fact that the insects are scattered quite generally over a tree and are not within sight of any one particular animal, this appears to be quite impossible. Furthermore, any follow-the-leader action on the part of the insects would result in a wave of light passing over the tree and originating from a definite point, a fact which is not the case once the synchronism has begun.

It is possible to inhibit the synchronism of a tree of insects by exposing them to a bright light for about a minute. When the light is turned off, the synchronism returns, having its origin, apparently, in some individual or group generally located in the central part of the tree. From this group, then, the synchronism extends over the entire tree in an irregular wave until all of the insects are flashing in unison.

Synchronism usually begins shortly after darkness has set in, the fireflies emerging from the nearby thickets and flying in an indirect course to the Sonneratia trees. During this flight to the trees there is no sign of a concerted flashing, the actions of the insects being similar to those found in our local forms during flight.

T. F. Morrison

Princeton University

[4] O. A. Reinking (Science, 53: 485, 1921) has de[...]scribed the flashing of fireflies from another district of [...]Siam. He has identified the form as belonging to the [...]genus *Calaphotia* and reports the rate to be from 105 to [...]109 times a minute.

[5] Sir J. Bowering. "The Kingdom and People of [...]Siam: With a Narrative of the Mission to That Country [...]in 1855." 2 vols., London, 1857. (vol. I, p. 233–4.)

THE KEEPING QUALITY OF HENS' EGGS

The preserving action of carbon dioxide on eggs as observed and reported by Sharp[1] seems to be the principle of the old and well-known domestic method of preserving eggs by burying them in some cereal grain, especially oats. Since cereals are known to expire carbon dioxide under practically all ordinary conditions of storage, it is obvious that eggs buried in them are surrounded by an atmosphere composed largely of carbon dioxide. Accordingly, the old household method of preserving eggs in cereal grains is equivalent in principle to the procedure discussed by Sharp.

O. S. Rask

School of Hygiene and Public Health,
The Johns Hopkins University

[1] Science, 69: 278, 1929.

ISOPLETH

In Science for July 13, Professor Lane tells of his need for a generic name for the lines used on maps to show equal values for various phenomena. He suggests that we make "isontic" the name for the genus that includes such species as "isobar," "isochlor," "isogam" and "isotherm."

I do not know how wide-spread the word "isopleth" may be. The "pleth" root refers to the plethora or degree of fulness in some respect. It is used by Huntington and Williams on page xii of the second edition of their "Business Geography," and elsewhere. I think that I have seen the term used by others, but I do not find it in my big Webster.

I dislike "isontic" because it sounds to me like an adjective instead of a noun. Besides, why make another name when there is a good one already?

Harold S. Palmer

The University of Hawaii

GENERAL FACTORS IN A TABLE OF INTERCORRELATIONS

In studying the intercorrelations of a group of character traits, the following technique was developed. It seems of such general application in constructing a battery of tests that it should be made available at once to those interested in this field. The steps in the method are as follows:

(1) Construct a table of intercorrelations of the tests according to the usual method.

(2) Pick out the group of tests having the highest correlations with one another, and by Spearman's formula ("The Abilities of Man," Appendix, p. xvi) determine the correlation of each of the tests with the supposed general factor.

(3) Take this general factor as the criterion and, having its correlations with the specific factors and also the correlations of the specific factors with one another, work out the multiple correlation of the specific tests with the general factor. Weight the individual tests and obtain the regression equation.

(4) Using the regression equation for two or more general factors, *e.g.*,

$$\frac{X_0 - M_0}{\sigma_0} = \beta_{01.2}\left(\frac{X_1 - M_1}{\sigma_1}\right) + \beta_{02.1}\left(\frac{X_2 - M_2}{\sigma_2}\right) + \dots + \beta_{0u(c-u)}\left(\frac{X_u - M_u}{\sigma_u}\right)$$

correlate the general factors according to the simple formula

$$r = \frac{1}{N}\Sigma \frac{x}{\sigma_x}.\frac{y}{\sigma_y}.$$

When this technique is employed, a number of tests with relatively high correlations may have to be discarded because their regression coefficients approach zero. Retaining only those with significant regression coefficients, we have so far found that, for the groups studied, Spearman's tetrad difference criterion holds and also Dodd's coefficient of equiproportion. Before eliminating the tests with zero regression coefficients, there were several high partials that disturbed the coefficient of equiproportion.

One advantage of the technique is that in constructing a battery of tests it settles the problem of the criterion and allows the determination of weights for all the tests, including the specific test which might have been available, according to the ordinary method, only as a criterion.

M. Rosa McDonough

Catholic University of America

QUOTATIONS

THE ELGIN BOTANIC GARDEN

When John D. Rockefeller, Jr., leased the "Upper Estate" of Columbia University for a great public improvement it was recalled that the land involved included a large part of the Elgin Botanic Garden, which was started in 1801 as a private enterprise on twenty acres of land which Dr. David Hosack bought of the city corporation for $4,807.36 and "a quit rent of sixteen bushels of good merchantable wheat to be paid every May in kind, or its equivalent in gold or silver." Dr. Marshall A. Howe, assistant director of the New York Botanical Garden, prints in the journal of that institution for March an interesting sketch of Dr. Hosack's enterprise, which eventually conferred on New York State its first publicly owned establishment of this nature.

Dr. Hosack was professor of botany at Columbia, and he labored unsuccessfully to induce the college, and later the state, to found a botanical garden. When he realized he could not accomplish this, he bought "nearly twenty acres of land" between the present Forty-seventh Street and Fifty-first Street, west of the Middle Road—now Fifth Avenue—a site then described as "distant from the city about three miles and a half." Dr. Hosack labored diligently in the garden, but eventually the burden of maintaining it became more than he felt he could bear. After much negotiation, in which he had the support of the County Medical Society, the governors of New York Hospital, the Mayor and Common Council, he succeeded in inducing the state to buy it under the provisions of "An Act for Promoting Medical Science

New York," the price of land and buildings being set eventually at $74,268.75, a sum less by $28,000 than the total of Dr. Hosack's investment and disbursements with simple interest computed at 6 per cent.

The state confided the administration of the garden to the regents of the university; the regents passed it along to the College of Physicians, disclaiming any responsibility for the cost of its upkeep. In 1814 the Legislature granted title to the land to Columbia College in legislation requiring the college to move within twelve years to this site or to one near by. The college did move up town, but not until 1857, when it went to Madison Avenue and Forty-ninth Street. By that time the Elgin Garden had become valuable, though the price its lease would eventually bring was not dreamed.

Dr. Howe says that the Elgin Garden was "apparently the first in America to come under public ownership." Its name was derived from the Scotch town in which Dr. Hosack's father was born. Thus the latest great improvement in New York links up with an earlier one. Perhaps Mr. Rockefeller will find a way to preserve the ancient name in his modern development.—*The New York Times.*

SCIENTIFIC BOOKS

The Fishes of Oceania. By Henry W. Fowler. Pp. iii+540, quarto, 82 figs., pls. I–XLIX. A faunal treatise on the fishes around and upon those island groups of the Pacific Ocean known as Polynesia, Micronesia and Papua. Memoirs of the Bernice P. Bishop Museum, Vol. X. Published by the museum, Honolulu, 1928.

Students of Pacific fishes have for years been obliged to consult the works of many authors in order to approach the subject as a whole. Bulletin of the U. S. Fish Commission, Vol. 23, 1903, "The Shore Fishes of the Hawaiian Islands, with a general account of the fish fauna," by Jordan and Evermann, has been the chief reliance for that archipelago, as has Jordan and Seale's "Fishes of Samoa," U. S. Bureau of Fisheries, Bull., Vol. 25, 1905, for that group. Pieter Bleeker's remarkable volumes issued between 1861 and 1878 revealed the colorful wonders of Papuan fishes. The long-felt need of a comprehensive work seems largely to have been met by the present memoir. This is really the corner-stone to a series of five volumes, now in preparation, on the colossal albatross collections in which the author plans to monograph the entire Indo-Pacific fish fauna.

His long experience in taxonomic work upon the world's fishes, his recent examination of the large Pacific collections in the Bishop Museum, in the Museum of Comparative Zoology and in the U. S. National Museum, in addition to those which he and his predecessors have brought together in the Academy of Natural Sciences of Philadelphia, have enabled Mr. Fowler, with access to a large body of literature, to establish upon a broad basis the distribution and relationships of the fishes composing this rich Oceanian fauna. His treatment, on the whole, is conservative, an aspect which will gratify many workers. At the same time his comprehensive synonymy should appease the "splitters." In a faunal work such as this he regards the purely taxonomic questions as largely secondary. The sequence of families followed is that of D. S. Jordan, 1923.

From the time of the early voyagers and discoverers the vivid coloration and variety of Pacific fishes have attracted attention, but extensive collections must be made in many more localities before much can be known of the distribution of many species. Ignorance of distribution sometimes leads to the description of questionable new species. "Although many sections, such as South Africa, East Africa, the Arabian Sea, the Bay of Bengal, the China Sea, the East Indies, the coasts of northern Australia, Melanesia, Micronesia, Polynesia and Hawaii may be defined more or less loosely as major faunal subregions, there still remains a large element of homogeneity in distribution." To illustrate the Indo-Pacific measure of the Oceanian ichthyfauna, the author has listed 445 species—a very small proportion of those actually known from Oceania—which range from East Africa or the western Indian Ocean well into Polynesia.

All the records discoverable of over 2,000 species, representing 179 families, appear, together with complete synonymy and references to literature containing them. Type locality is given with the original reference. In the cases of species for which material was not available for Oceania, Fowler has furnished diagnoses, usually brief, compiled from original or trustworthy descriptions.

Eighty-two excellent drawings, many of them depicting young stages, appear in the text. In preparing the plates 108 of the remarkable colored fish models in the Bishop Museum were photographed. A bibliography of 170 works and a 47-page index are provided.

And with all this the author estimates that probably not much more than half of the species inhabiting Oceania have yet been described, regarding his present volume as "only a contribution to the ichthyfauna of that vast ocean expanse."

That this publication is intended chiefly for ichthyologists may be inferred, if only from the complete absence of popular names, either English or native.

S. C. B.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A THREE-DIMENSIONAL THERMO-ISOPLETH

The visualization of invisible phenomena has long been a problem to the student beginning his study of the atmosphere. This difficulty is materially lessened with familiarity with the methods of observation and the devices used in the graphical portrayal of climatic data. The methods of representation have become so conventionalized that the initiated has little difficulty in visualization. The various curves used to show the march of temperature through the day, the month or the year are commonplace. The grids, or coordinates, may differ somewhat depending upon the maker but the curves necessarily are much alike. Some grids are so drawn as rather to over-emphasize the range in temperature, and others made especially for a certain set of data will not accommodate data from another region. Such diagrams as these are simple two-dimensional devices and adequately serve their purpose. But there are occasions when a three-dimensional device would be useful, provided it could be simply drawn and easily comprehended.

The diagram designed by Davis[1] to show the distribution of insolation over the earth is such a device and has been widely used by other authors. The coordinates representing the months of the year and the latitude make an isometric base on which the data of insolation are shown. The effect is a model-like diagram which may be described as a three-dimensional symbol. In spite of its value as a teaching device students continue to experience some difficulty in interpreting it. However, its continued use is sufficient testimony that it is a valuable aid to the understanding of the distribution of insolation.

The accompanying diagram is the result of an experiment in the graphical presentation of mean hourly temperatures. The common method used in depicting these data is a rectangular diagram with one set of coordinates representing the months, and the other set the hours of the day. The isotherms are then drawn on this grid and the completed diagram resembles a simple contour map. Such a diagram is called an isopleth, or a thermo-isopleth.

The method used in the construction of this diagram was suggested in a paper by Dr. Mead,[2] of the department of geology, University of Wisconsin, who has used this device for giving the ordinary topographic map a relieflike appearance. The student who is familiar with a contour map experiences no difficulty in visualizing the land forms from the symbols used on the map. Similarly, the meteorologist finds it no problem at all to interpret a thermo-isopleth. But both the contour map and the isopleth are decidedly flat diagrams to the amateur.

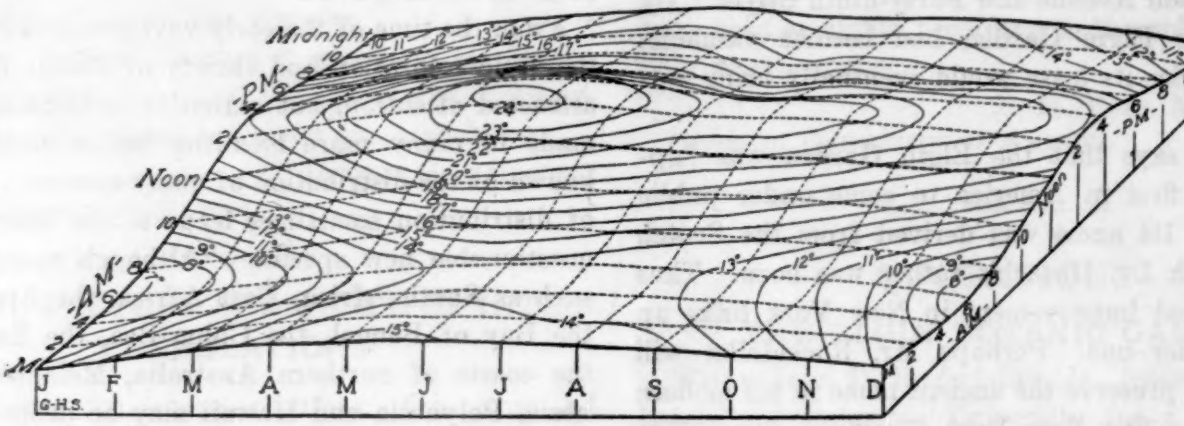


FIG. 1. A three-dimensional thermo-isopleth for Mexico City. The isotherms are drawn, one for each degree Centigrade.

The data used in the drawing of this diagram were taken from Hernández's monograph on the temperature of Mexico.[3] From the same data he constructed a conventional thermo-isopleth for Mexico City, but the accompanying diagram was made as an attempt to alter the old symbol. The construction of the diagram required two stages. The first was the devising of a base which was to be used as a grid. Instead of making the conventional grid, an isometric base was drawn, using the months for one set of coordinates and the hours as the other set. Upon this the mean hourly temperatures were plotted at the appropriate intersections. The isotherms for each degree Centigrade were then drawn, and the resulting diagram was in reality an isopleth on an isometric base, and otherwise not unlike the one made by Hernández.

[1] W. M. Davis, "Elementary Meteorology," p. 21, Boston. 1902.

[2] W. J. Mead, "A Simple Method for Making Block Diagrams," *The Wisconsin Engineer*, 25: 24–25. Nov. 1920.

[3] Jesus Hernández, "The Temperature of Mexico," *Monthly Weather Review, Supplement*, No. 23, 1923, pp. 12.

The second step in construction produced an entirely different effect. The first diagram became the basis of the new one. Along the edge of the isometric base a graduated vertical scale was drawn with the divisions—one for each isotherm—about one millimeter apart. On a new piece of tracing cloth a single marker was drawn in such a way as to coincide with the lowest division on the vertical scale. The tracing cloth was attached to a T-square in order to ensure that it could be moved the appropriate interval and maintain the same direction. With the index of the tracing on the lowest division of the vertical scale the highest, or warmest, isotherm was redrawn on the tracing. By moving the tracing upward one division on the vertical scale the next lowest isotherm was drawn, and in the same manner each lower isotherm was added to the diagram. Also the intersections of the coordinates with the isotherms were indicated, so that they could be drawn in later. After all the isotherms were drawn the ends were connected by a heavy line which had the effect of making the device appear as a block-diagram. The drawing-in of the coordinates helped to create the desired optical illusion, and the adding of a base completed the diagram except for the lettering.

A very similar three-dimensional diagram may be made on an isometric base by erecting at each intersection a vertical line representing the mean hourly temperature. The top ends can then be connected by a smooth curve more or less parallel with the corresponding coordinate. Only the coordinate curves should be shown in the completed diagram. The resulting isopleth will resemble the diagram Davis made to show the distribution of insolation.

To facilitate the construction of a block diagram from a contour map a special pantograph has been designed by Castelnau.[4] Even with the assistance of such equipment the isopleth-block diagram may require more time than its value will justify. However, the writer has found it very useful for the display of the mean hourly temperatures throughout the year.

GUY-HAROLD SMITH
UNIVERSITY OF ILLINOIS

A METHOD FOR PURIFICATION OF EXTRACTS CONTAINING THE GROWTH-PROMOTING PRINCIPLE OF THE ANTERIOR HYPOPHYSIS[1]

IN 1921 Long and Evans[2] produced gigantism in rats by daily intraperitoneal injections of saline extracts of the anterior lobe of the bovine hypophysis. In the Harvey Lectures of 1923–1924, Evans[3] described more refined methods for the extraction of the growth-promoting principle. The most potent extracts were prepared by means of extracting the ground anterior lobe tissue with sodium hydroxide and subsequently bringing the extract to approximate neutrality with acetic acid. Evans and Simpson[4] have recently reported success in obtaining growth in adult female rats with the daily administrations of as little as one eighth to one fourth cubic centimeter of such a preparation.

A modification of the method first described by Evans which made it possible for us to prepare sufficient quantity of a sterile potent extract for use in dogs has been described in a previous communication.[5]

Some months ago a study of the blood chemistry of dogs receiving this growth-promoting substance was begun, and it became desirable to free the extract from the bulk of non-protein nitrogen and certain inorganic substances. Since success had not been attained in freeing the principle from proteins an attempt to fractionate the protein was made. After a preliminary trial of salts for fractionation, sodium sulphate was selected.

Method: The usual neutralized alkaline extract is prepared as described in a previous communication. The solution is cautiously warmed to 35° C., and twenty grams granular anhydrous sodium sulphate for each 100 cc of extract is added slowly and with stirring. After about fifteen minutes the precipitate becomes flocculent and may be easily filtered. The washed precipitate is pressed as dry as possible and is taken up in one half the original volume of water.[6] The redissolved precipitate is filtered through a sterilized Seitz filter and is then ready to inject. The protein precipitate consnsts of globin euglobulin and pseudo-globulin. Further separation of the euglobulin and pseudo-globulin fractions has resulted in a division of the growth-promoting substance between the fractions. The fraction from 20 per cent. to 35 per cent. sodium sulphate which brings down nearly all of the remaining protein has not resulted in growth. The redissolved globulin extract is slightly lower in protein than the original preparation, and the sugar, phosphates, non-protein nitrogen and uric acid are reduced to traces.

[4] Paul Castelnau, "La théorie du bloc-diagrams," *Bull. de la Société de Topographie de France*, July–August, 1912, pp. 121–136.

[1] From the Surgical Laboratory of the Harvard Medical School.

[2] Evans and Long, *Anat. Rec.*, 21: 62, 1921.

[3] H. M. Evans, Harvey Lectures, 1923–24.

[4] H. M. Evans and M. E. Simpson, *Jour. A. M. A.*, 91: 18, 1928.

[5] T. J. Putnam, E. B. Benedict and H. M. Teel, *Am. Jour. Physiol.*, 84: 157, 1928.

[6] There is sufficient sodium sulphate in the precipitate to redissolve this water-insoluble protein fraction. There is also a small amount of lipoid material which does not go back into solution.

The presence of the growth-promoting principle in the globulin group is in accord with the observation of Evans that alkaline extractives are most efficient. Further after the addition of twenty volumes of water to a paste of ground glands, the growth effect appears to be in the water-insoluble fraction which further suggests the adsorption with or identity of this substance with the globulin and water-insoluble group of proteins. It is interesting that the growth-promoting principle is destroyed by about the same temperature as that at which this group of proteins is denatured.

SUMMARY

(1) The growth-promoting principle of the anterior hypophysis may be salted out of the more crude extracts by means of sodium sulphate.

(2) Attempts to further fractionate the globulin group of proteins in which the growth-promoting principle comes down resulted in a division of the substances between the fractions.

HAROLD M. TEEL

SURGICAL LABORATORY,
HARVARD MEDICAL SCHOOL

SPECIAL ARTICLES

THE FIRST SPECTRUM OF XENON[1]

A NEW list of estimated intensities and measured wave-lengths has been obtained for about 300 lines characterizing the first spectrum of xenon. The observed wave-lengths range from 3442.7A in the ultraviolet to 9923.10A in the infra-red. Spectral terms which account for practically all of these lines have been identified. The largest term is $^1S_0$ (p_0) representing the normal state of the neutral atom. The value of this term in xenon is 97835; from it the ionization potential of 12.078 volts is derived. In the notation introduced by Paschen in his analysis of neon the main atomic energy levels may be grouped as four *s*-terms, ten *p*-terms and twelve *d*-terms. These in turn are each separable into two subgroups coordinated to the two $^2P_{2,1}$ levels of the rare gas ion. The absolute values of the four *s*-terms and of the set of *p*-terms related to the lower level of the Xe^+ ion are as given.

Inner quantum numbers are shown in the first column while the last contains the separations of the levels; the large value between $1s_4$ and $1s_3$ is connected with the coordination of these levels to the $^2P_{2,1}$ levels of the Xe^+ ion which appear to be separated by 9621 cm^{-1}. The general features of the Xe I

2	$1s_5$	30766.90	
			977.64
1	$1s_4$	29789.26	
			8151.60
0	$1s_3$	21637.66	
			988.30
1	$1s_2$	20649.36	
1	$2p_{10}$	20565.23	
			850.58
2	$2p_9$	19714.65	
			283.24
3	$2p_8$	19431.41	
			552.98
1	$2p_7$	18878.43	
			256.48
2	$2p_6$	18621.95	
			906.47
0	$2p_5$	17715.48	

spectrum closely resemble those of the analogous spectra Ne I, A I, Kr I, and are in excellent accord with the theoretical expectations. Complete details of the wave-length measurements and analysis will appear in an early number of the Bureau of Standards *Journal of Research.*

WILLIAM F. MEGGERS
T. L. DE BRUIN
C. J. HUMPHREYS

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

DEVELOPMENT OF THE MOUSE ADRENAL

BETWEEN the cortex and the medulla of the adrenal gland, a band of tissue which is free of adrenalin has been observed by Cramer[1] in mice which had received adrenalin injections. He describes this tissue as medullary tissue which is drained of its adrenalin and inhibited from producing more by a mechanism of secretory control which reacts to the presence of excess adrenalin in the circulation. He observes "essentially the same changes" after such various experimental treatments as injection of thyroid extract and exposure to heat.

The writer failed to find this reaction following adrenalin injections, but has observed similar appearances in experimentally untreated mice, in the course of the development of the adrenal.[2] It is suggested that this normal stage in development could account for Cramer's observations.

Adrenalin injections were made into adult male mice, following Cramer's procedure of the injection of 0.015 mg of adrenalin per mouse, and fixation of the adrenals after twenty minutes. The tissue was

[1] W. Cramer. *Brit. Jour. Exp. Path.*, 7: 88, 1926, quoted by G. N. Stewart, in Cowdry's "Special Cytology," 1: 636.

[2] E. Howard Miller. *Amer. Jour. Anat.*, 40: 251–298, 1927; and R. Deanesly, *Proc. Roy. Soc.*, B, 103: 523, 1928.

...d in 3 per cent. potassium dichromate, which ...cts to form a brown precipitate in cells which ...tain adrenalin.[3] In these specimens no alteration ...the normal intensity or extent of this reaction could ...observed.

...In experimentally untreated normal mice, at certain ...ges of development, a wide band of tissue may be ...und between cortex and medulla which does not ...e the reaction with bichromate at any time, and ...ich during the first part of its existence does not ...in with Sudan III, in contrast to the overlying ...rtex. This band of tissue is definitely separated ...om the overlying cortex by cellular differentiation ... the boundary. On the other hand, there is no ...nnective tissue band between this intermediate tissue ...d the medulla, but the cell groups intermingle. The ...mbined effect is strongly suggestive of a medulla ...hich has lost part of its adrenalin. However, this ...es not seem to be the case, because one can follow ...e development of this intermediate zone of tissue ...om a very narrow inner band of cortex cells.

At two weeks of age in the mouse the zone develops ...ery quickly, degenerates in the male before sexual ...aturity is reached, and degenerates in the virgin ...emale during the first half of the reproductive period. ...On the degeneration of this inner zone the usual type ...f boundary between the medulla and the cortex is ...stablished. The apparent close connection of this ...one with the adrenal medulla may be explained as a ...esult of simple mechanical factors operating during ...ts growth.

This reaction occurs normally in the mouse as ... phase of development. An apparently similar ...equence of events is found in the human adrenal ...during the first year of life. Analogous reactions in ...other species have not been reported.

It is this large cortex zone which Cramer seems to have described as "exhausted medulla." Although it may be possible to produce the zone experimentally by other means than adrenalin injections, it should be recognized as cortical rather than medullary tissue.

E. Howard Miller

University of Pennsylvania

[3] E. H. Miller. *Amer. Jour. Physiol.*, 75: 267, 1926.

STRUCTURE OF PLANT COMPOUNDS AND SOLUBILITY

During some recent work in plant analysis the writer had occasion to work with a number of organic acids and was surprised to find how readily certain carbohydrates, as well as other plant constituents, dissolved in cold formic acid of about 75 per cent. or more of acid. It is well known that the different sugars are quite soluble in water, and also that as the molecular weight increases and the structure becomes more complicated the solubility is decreased. Thus there is a lessened solubility among the carbohydrates in about the following order—dextrose, sucrose, raffinose, dextrins, starch, pectins, mucilage, gums (cherry), lignin, cellulose, etc. Hence, as the carbohydrate ladder is ascended from dextrose toward cellulose, each rung brings new structures not well understood. The term carbohydrates includes all the simple sugars and all substances which can be converted into simple sugars by hydrolysis. It is known that there is much variation in solubility even among starch grains. When some are boiled in water they break loose from their shells of amylo-pectin material leaving amylose in solution, and the shell coverings may be separated by filtration. Other starches do not even break open, but only swell and tend to form a gel structure.

Formic Acid Dissolves Starch Groups

Although water does not dissolve many of these carbohydrate compounds, it was found that formic acid dissolves not only sugars but also dextrin, starch, inulin, glycogen, agar, chlorophyll, glucosides, etc., together with some of the plant pigments usually found combined or associated with glucosides, as the blue from privet berries giving a wine-colored solution, the pigment from cotton-seed meal which gives the solution a very red color, and also chlorophyll from tomato leaf giving a blue-green solution. Formic acid does not dissolve much mucilage, cherry gum, lignin, cellulose, or proteins in the cold (unless very concentrated acid is used). When starch is dissolved in this acid it makes a clear syrupy liquid partly hydrolized as it gives a blue color with iodine solution shortly after dilution with water, but not after standing. Corn and potato starches are precipitated when the syrup is diluted with water, but inulin remains in solution.

Formic Acid in Relation to Photosynthesis

Erlenmeyer[1] in 1877 suggested that formic acid is the most probable intermediate compound in the production of carbohydrates by photosynthesis. He believed that the synthesis took place by a reduction of carbonic acid producing formic acid and hydrogen peroxide. Wislicenus[2] in 1918 concluded that the hydrogen peroxide produced as a by-product to formic acid probably brings about a further reduction in the plant, resulting in the production of formaldehyde in the presence of light and leaf pigments.

[1] Erlenmeyer, *Ber. Deut. Chem. Ges.*, 10: 634–637. 1877.

[2] Wislicenus, *Ber. Deut. Chem. Ges.*, 51: 942–965. 1918.

It was shown by Spoehr[3] in 1923 that when formaldehyde vapor is mixed with air it is oxidized to formic acid; also that formic acid may be produced by the action of ultra-violet light upon carbon dioxide and water, and that further exposure of the acid to this light produced a non-volatile syrup which resembled the simple sugars in some of their properties. It is known, too, that when dextrose is heated with some mineral acids formic acid is one of the acids produced, as shown by the following equation:

$$C_6H_{12}O_6 \longrightarrow C_5H_8O_3 + H\ COOH + H_2O.$$

Thus dextrose not only yields formic acid as one of its decomposition products, but is probably a constituent in the chain of its construction. Since it is possible to produce formic acid by the action of light on carbon dioxide and water, and since some of the carbohydrates found in plants yield this acid on decomposition and are of such a structure as to be soluble in this acid, and possibly *only* in this acid, the formic acid theory of photosynthesis receives added support.

Peculiarities of Formic Acid

This acid is unique among the organic acids not only because it is the strongest, being about twelve times more highly ionized than acetic or others in the series, but also because it has properties of an aldehyde as well. When this acid comes in contact with a solution of silver, or mercury salt, a deposit of metal is produced similar to that formed when other aldehydes are added. Hence the solvent action of this acid on carbohydrates may be linked with the presence of aldehyde grouping in the carbohydrate.

Formic Acid and Insect Life

This acid may be produced also by insect life as well as by plants. It is said to be the cause of the irritation of the skin noticed when one is stung by a bee, ant or nettle plant; also it is often found to be a constituent of honey.

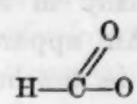
Structure of Carbohydrates as Related to Solubility in Formic Acid

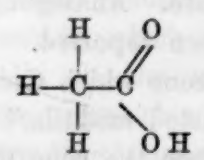
It will be noted from a consideration of the different carbohydrates which are soluble in formic acid that this acid is quite selective in its solubilities. Thus sugars, dextrins, starches and glucosides, which are easily hydrolized, yielding aldehyde and ketone groups, are readily soluble in formic acid, whereas fats, proteins, gums, lignin and cellulose do not readily dissolve. This indicates that the starch structure is essentially different from the cellulose molecule even though they both produce *only* glucose residues on hydrolysis. It is known that while dextrose has five hydroxyl groups to six carbons in the molecule, starch, according to Irvine,[4] has but three; and cellulose, according to Malm and Clark,[5] has but one hydroxyl in twelve, which is chemically different from the rest and is capable of esterfication. They conclude that the cellulose molecule may therefore be expressed as a multiple of the unit $C_{24}H_{40}O_{20}$. Hence the solubility of carbohydrates seems to lessen about as the active hydroxyl groups decrease and the carbons increase.

Polar and Non-polar Plant Structures

It is well known that plant compounds which contain the hydroxyl or carboxyl groups as sugars and organic acids are quite reactive and are often spoken of as polar compounds, whereas fats and cellulose would be representative of the inactive or non-polar compounds. This may partly account for the lack of solubility in formic acid of the germs and bran, etc., of the cereal grains; for the solubility of chlorophyll containing carboxyl groups; and for the insolubility of caratin from a carrot which is a hydrocarbon and is a non-polar compound.

A further reason for the great solubility of formic acid among the carbohydrates resides in its polarity. This acid with its single carbon atom would have two unsaturated linkages not present in those having two or more carbon atoms in the molecule. These relations may be represented as follows:

 = formic acid;

 = acetic acid.

Thus it is evident that this acid is a very polar compound capable of great activity on many semi-polar compounds and able to put them in solution.

It is hoped that this discussion will serve to make the properties of this unusual acid better known in order that it may be of service in several fields of science in making separations or identifications of various plant tissues, and thus through its selective solubility further our knowledge of the constituents of plants.

R. H. Carr

School of Agriculture,
Purdue University

[3] Spoehr, *Jour. Amer. Chem. Soc.*, 45: 1184–1187. 1923.

[4] Irvine, *Chem. Rev. 1*, 1: 41–71. 1924.

[5] Malm and Clark, *Jour. Amer. Chem. Soc.*, 51: 274–279. 1929.